NASA SCIENCE HIGHLIGHT: Science Mission Directorate (SMD)

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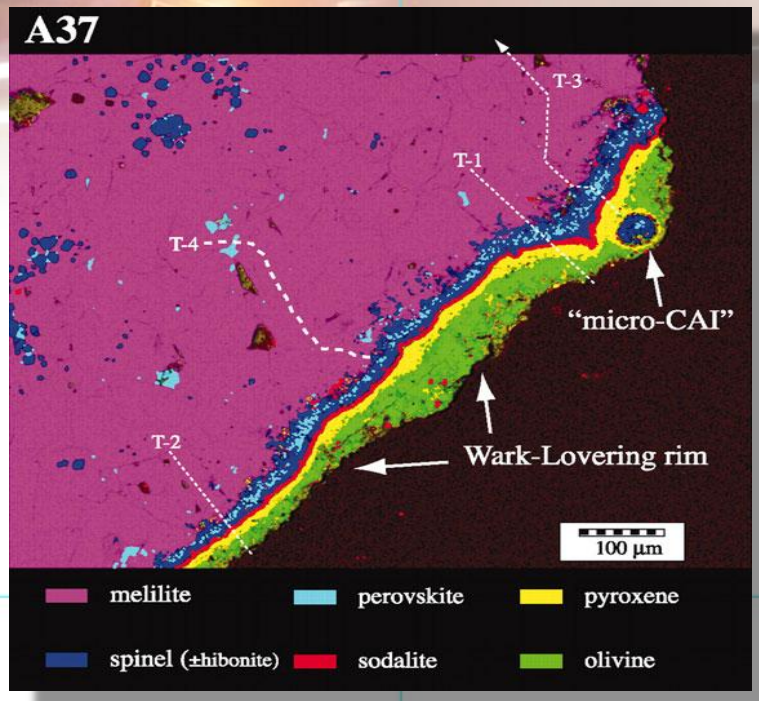
NASA Science Highlight: Planetary Program Support

Research by Justin Simon, et al, NASA's Johnson Space Center, Jet Propulsion Laboratory
Science Writer, Samantha Harvey

Oxygen Isotope Variation in Meteorite Provides Insight Into Planet Formation



Allende is the largest carbonaceous chondrite meteorite ever found on Earth. It fell to the ground in 1969 on the Mexican state of Chihuahua. One of the most studied of all meteorites, it is notable for possessing abundant CAIs..

NASA scientists conducted research on a meteorite and have provided new evidence that the inner planets formed from materials spread far and wide in the early solar system, and not just from nearby matter. Oxygen isotopic measurements in the core and outer rim of a calcium-aluminum-rich inclusion contained in the Allende meteorite record the entire range of oxygen isotopic composition previously measured in all solids in the solar system.

Oxygen Isotope Variation in Meteorite Provides Insight Into Planet Formation (Cont'd)

Allende meteorite. Image credit: NASA GSFC

The research provides the first measurements to show that early forming solids experienced vastly varying environments during the planet-forming period of our solar system. The study substantiates ideas that the terrestrial planets—Earth, Mars, Mercury and Venus—formed as a result of materials accreting from various sources across the protoplanetary disk rather than from just a nearby region.

Justin Simon, NASA planetary scientist in the Astromaterials Research and Exploration Science Directorate at NASA's Johnson Space Center in Houston and lead author of the paper explains, "To find, in one grain of nebular dust, values that systematically span nearly the entire oxygen isotopic range is remarkable. It requires that we take a critical look at our current models for protoplanetary disk evolution."

A protoplanetary disk is a disk of dense gas surrounding a newly formed star. Concepts of how protoplanetary disks evolved have been the subject of debate for many years.

Using the NanoSIMS (nanometer-scale secondary-ion mass spectrometer) at Lawrence Livermore National Laboratory (LLNL) in Livermore, Calif., Simon and scientists from NASA's Jet Propulsion Laboratory, LLNL, the University of California, Berkeley, and the University of Chicago measured the concentrations of oxygen isotopes found in a calcium-aluminum-rich inclusion (CAI) contained in a piece of the Allende meteorite.

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Protoplanetary Disk Formation

Implications:

Scientists once adhered to a "feeding zone" theory of planet formation, believing that a planet developed by accreting material by and large only at the same distance from the sun as its orbit. In the early 2000s this model changed as theoretical modelers proposed that instead of all the material coming from the same "feeding zone," large amounts of materials came from regions both closer to and farther from the sun.

Significance to Solar System Exploration:

According to scientist Justin Simon, in challenging the "feeding zone" theory, this sample analysis is the first actual, measurable evidence in a sample that this new idea of material going in and out is the real story. Results from sample analysis confirm, for the first time, the radial transfer model of planetary formation.